



# Bias Adjustment

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## Reasons for Adjustment

- Retrievals relate
  - A change in measured radiances
- To
  - A change in the state vectors that describe the atmosphere
- Need
  - A **bias free** way to estimate the radiances from the state vectors
- Biases in the retrieval result from biases in
  - Measurements
  - Forward calculation
  - “Truth”



## Correction Choices

- Bias removal
  - But most change as a function of latitude etc.
  - Assumes a form for the adjustment
- Transmittance adjustment
  - Changes with atmosphere
  - Assumes a form for the adjustment
- Systematic error removal
  - Changes as a function of the profile and
  - Other predictors
  - Removes all systematic differences with no assumptions other than
    - They are linear with the predictors
    - But predictors can be nonlinear



## Bias Removal or More

- Many errors are more than biases
  - Errors in the radiative transfer calculation
    - Spectral response function for the instrument
    - Errors in the calibration
      - Non-linear response
      - Imperfect black body
      - Stray light
    - Atmospheric physics
    - ???
- Remove all systematic differences
  - Predict the adjustment from a representation of the atmospheric state



## Predictor Choices

- Guess dependent – Input profile
  - Changes with iteration
  - Requires calculation for each iteration
  - Present in really contaminated areas but representative?
- Measurement dependent – measured brightness temperatures
  - Calculated once from the measurement
  - Iterates if cloud clearing and retrieval are linked and IR channels are used
  - Microwave channels avoid this
  - Needs adjustment in contaminated areas



## Predictor choices continued

- Other predictors
  - Location
  - Season
  - Scan angle
  - Solar zenith angle
  - Surface elevation
  - Surface pressure
  - CO<sub>2</sub> amount
    - But knowledge is only for surface
  - Other trace gases



## What is truth?

- Each model has a number of inputs
  - Radiosondes
  - Satellite
  - ACARS
  - Etc.
- All are adjusted to a common estimate of truth to make them consistent
- Each model's estimate of truth has some error
- A perfect measurement (no error) will be adjusted to the model "truth" in the model
- In practice there is probably no one adjustment for all centers
- We provide our best estimate of absolute truth



## Truth sources

- ARM sites
  - Highly accurate
  - Low numbers
- ACARS reports
  - Do not provide complete profiles
  - Good accuracy
    - Moisture probe is in a heated environment
    - New instrument is being deployed
- Radiosondes + GPS
  - GPS can be used to check/adjust radiosonde moisture
  - Radiation corrections for temperature
- Lidar
- Conventional radiosondes





## Predictor Choices

- All radiances
  - IR must be clear
- AIRS radiances
  - Must be clear
- AMSU radiances
  - Land/water emissivities
  - No heavy rain
- Note that only general knowledge of the atmosphere is required
  - We have 2 options IR and microwave
  - Microwave is easier



## Summary

- Bias adjustment
  - Remove all systematic biases
  - Apply correction at the retrieval step
    - Don't tamper with the measured radiances
  - Use radiances as predictors
    - Currently using IR with microwave as an option
    - Microwave is avoids some potential problems
    - Add other predictors
      - Location
      - Season
      - Scan angle
      - Solar zenith angle
      - Surface elevation
    - Consider
      - Surface pressure ? Model dependent
      - CO2 amount - total column estimate?



## Radiosonde adjustments

- Adjust all radiosondes to a common type Vaisala
  - Error characteristics are well characterized due to use at the ARM sites
- Becoming less of a need because of the dominance of the Vaisala radiosondes
- Large areas are not covered
  - China
  - Russia



## Diagnostics as opposed to bias correction

- Unsupervised classification
  - Classify all radiances into groups
  - Assign causes to the groups
- Bayesian classification
  - Need training set
- Eigenvector detection
  - Generate eigenvectors for one type of data
    - Don't use the all the eigenvectors
  - Calculate the Principal Component Scores
  - Reconstruct the radiances
  - Look at the differences



## Effects

- Cloud contamination
- Sun glint
- Solar contamination
- aerosols

